

Science Education 201: Matter and Energy in Physical Systems

Fall 2024

Class meetings: **Face to Face** MWF 10:00 - 11:50 am
Instructor: Dr. Emily Borda she/her/hers bordae@wwu.edu, SL 250D
Drop-in Hours: Tues 1:30-2:30, Fri 2:30-3:30 in SL 250D or Zoom OR by appointment
Teaching Assistant: Morgan Stucky, stuckym@wwu.edu, SL 220

WHY SHOULD I TAKE THIS COURSE?

This is a student-centered, discussion-oriented physics course for all students but especially targeted to those pursuing a career in elementary teaching. If you are going to be an elementary teacher, you will teach science! If you are a citizen of this world, you need some understanding of science! This course will help you develop some foundational ideas in science, and even more importantly, will model scientific processes like interpreting evidence and developing scientific explanations. These skills are important not only for teachers and their students, but for all of us to function in today's society, which demands some level of scientific literacy. You will learn science in ways different from many other school science experiences - by evidence seeking, collaboration, and consensus building. In that way, our course models not only a vision for elementary school science but also how science out there in the world proceeds. We will also explore sources of inequity in the STEM workforce and discuss ways in which we can create classroom environments to help all children see themselves as "science people." In doing so, I hope you will too!

WHAT WILL I GET OUT OF THIS COURSE?

This course has four major learning goals:

- 1) **Physics content.** Students develop deep understanding of basic physics concepts to explain everyday phenomena. Topics include those emphasized in elementary grades.
- 2) **Scientific practices.** Students develop knowledge of science and engineering practices defined in the Framework for K-12 Science Education, and link these practices to their experiences in class.
- 3) **Learning about learning.** Students develop awareness of how their own ideas change and develop, and how the structure of the learning environment and curriculum facilitates these changes.
- 4) **Equity in STEM fields.** Students develop awareness of structural and cultural issues that limit representation in STEM. Students learn how this limits the STEM and society, and will explore its implications for K-8 STEM instruction.

As an LSCI GUR, this course also fulfills the following GUR competency: *Use quantitative and scientific reasoning to frame and solve problems.* The following literacies and core competencies are also addressed in this course: *Quantitative, scientific, and technological literacies; creative and problem-solving literacies; and critical and reflective literacies.*

WHAT MATERIALS WILL I NEED?

A SCED 201 coursepack (purchased at the bookstore). This packet contains modules from the Physics and Everyday Thinking curriculum, specifically developed for future teachers.

WHAT WILL OUR CLASS MEETINGS BE LIKE?

We will develop and apply an energy-based model and a force-based model for motion and interactions for real-world situations. There will be little traditional lecturing. Instead, you will generate knowledge through your own work and discussion. I will serve as a facilitator rather than the source of knowledge. Thus, learning is student directed and achieved through collaboration and consensus between you and your peers. For this reason, [attendance](#) is required.

HOW CAN I POSITIVELY CONTRIBUTE TO OUR CLASSROOM CLIMATE?

All students are capable of understanding and doing science. I want you to embody this idea and, for those of you who become teachers, impart it to your future students. We will establish and maintain a classroom climate that is inclusive and respectful of all students. Learning includes being able to voice and hear a variety of perspectives, and classroom discussion is essential to building your knowledge and understanding. We will work hard to create an environment where it is safe to share ideas, even if they may be different from other students' ideas, or if we are afraid they might be wrong. I want all students to succeed, regardless of race, gender, ethnicity, preconceptions, personality, or learning style.

HOW CAN I MAKE THE MOST OF MY AND MY GROUP'S LEARNING?

First things first: **If you feel any cold/flu/COVID-19-like symptoms, do not come to class.** Otherwise, this is a collaborative class, which hinges on experimentation and discussion. Thus, it is important to attend all class meetings and arrive on time. However, I know that life happens. Each student will get 3 free absences, no questions asked. I strongly advise you to save these for when you really need them - you can't plan for illnesses. Each absence thereafter will drop your course grade by $\frac{1}{3}$ of a letter grade (e.g., B instead of B+), unless you have a long-term illness, elongated family emergency, etc., in which case please contact the [office of student life](#) who will coordinate with me to make a plan.

If you miss a class:

- Communicate with your group to see what we worked on.
- Do the activity on your own. If needed, watch [movie\(s\)](#) to substitute for experiment(s) in class.
- Complete the homework to the best of your ability and turn it in at the next class meeting.

Late arrivals. Due to the intensely collaborative nature of this class, it is imperative that everyone arrives to class on time and ready to go. Late arrivals are unacceptable and will negatively impact your grade. Three late arrivals (5+ minutes each) will be marked as an absence.

Communication. I use Canvas announcements to communicate to the whole class and email to communicate with individual students. You are expected to check your WWU email and Canvas daily.

Late work. I would rather have you do the work late, than not do it at all. While it is important to keep to deadlines, sometimes life happens and you may not be able to turn something in on time. I will accept homework assignments late, with a ~25% point deduction per class day late. For example, for a 4 point assignment that is due Wednesday, if you turn it in Friday, 1 point will be deducted for lateness. If you turn it in Monday, 2 points will be deducted. I will generally not accept Midterm quizzes late. If you experience an illness or emergency that prohibits you from submitting a midterm quiz on time, please email me as soon as possible to let me know, and we can discuss options.

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HOW WILL YOU AND I EVALUATE MY PROGRESS?

You will earn a base grade that will be determined by your scores and completed work for all work products except mini-projects. This grade will then be modified by your engagement with the [mini-projects](#). Your base grade is determined through a points-based grading system. Each assignment except mini-projects will carry a certain amount of points. For some assignments, points are awarded based on completion and effort. For others, they are awarded based on correctness. Each assignment type is worth a percentage of your base grade, as shown below. You should strive to complete all the assignments, because they are the way you will learn the material. However, I realize life happens. To give you some wiggle room, for some assignment types, one or more of your lowest scores will be dropped, as shown below. If circumstances arise where you will need added flexibility (e.g., long-term illness), please email me and we can work out a plan. Most assignments will be administered by/turned into Canvas. For many assignments, you will have the chance to turn in revisions for a better grade. Sometimes this will even be required.

Grade category	Description	Percent of base grade	Number of lowest scores dropped
Participation	Your participation grade will be based on: active participation in small and large group discussions as measured by self and peer evaluations; up-to-date workbook; and completion of pre- and post-instruction surveys.	20%	1
Review Assignments	After most activities, there will be a review assignment to reinforce ideas developed in the activities, provide practice applying the key ideas to new situations, and offer opportunities for feedback on your thinking. In some cases, review assignments will contain a reading, reflection survey , and/or discussion board assignment. There will be revision opportunities for most Review Assignments.	25%	1
Extension Activities	Extension activities are online multiple choice activities that check understanding and introduce new ideas. They will be assigned after we complete most activities, and will be due at the start of the following class. You will have unlimited attempts to get 100% on the Extensions, and I highly recommend you do so.	15%	1
Midterm Quizzes	There will be three take-home midterm quizzes. You may refer to your notes and other materials from class. After your midterm is returned, you will make revisions based on the feedback you received.	25%	0
Collaborative Final Project	Together with one or two classmates, you will engage in a final project instead of taking a final exam. Details about the project will be given at least 2 weeks prior to the due date .	15%	0

Your base grade will then be determined using the following grading scale:

	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
%	93+	90	87	83	80	77	73	70	67	63	60	59-

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Modifying your base grade. Mini-projects will be used to modify your grade. Two are required. Failing to turn in two mini-projects will decrease your grade. Turn in more to boost your grade. You decide which weeks to turn in a mini-project, and what form it will take. You will always have several options to choose from for your mini-project (these are listed on Canvas), but more options will be added as we develop concepts during the quarter. Some examples include: writing about a scientist of color; connecting a consensus idea we developed in class to your everyday life; or building a Rube Goldberg machine.

A rubric will be used to grade mini-projects. For a mini-project to count, it needs to: 1) be turned in on time, and 2) fully satisfy all rubric criteria. You will have an opportunity to turn them in most Mondays. You will be given unlimited revision attempts to satisfy rubric criteria, but failing to do so will result in a mini-project not being counted. The table below summarizes how mini-projects will work.

Number of on-time* mini-projects that meet all rubric criteria	Affect on your base grade
0-1	Lower by 1/3 of a letter grade (e.g., from A- to B+, C+ to C)
2-3	Stay the same
4+	Boost by 1/3 of a letter grade (e.g., from B to B+, C+ to B-)

*The original mini-project needs to be turned in on time, but if it doesn't at first meet all rubric criteria and needs to be revised, it still counts as long as you eventually make the revisions and meet all criteria.

TENTATIVE SCHEDULE

Dates	Units/Topics	Guiding questions
Week 1 (9/25-27)	<ul style="list-style-type: none"> Course overview Classroom agreements Mystery Tube Activity and the nature of STEM 	<ul style="list-style-type: none"> What is the structure of this course? How do I succeed in this course? How can we create a collaborative and productive classroom environment? What is scientific modeling and why is it important? To what extent is science objective or subjective? What is important to teach about science in elementary and middle school? Why?
Week 2 (9/30-10/4)	<ul style="list-style-type: none"> Driving questions: interactions and motion EM-A1: Interactions and Motion EM-A2: Motion and Energy 	<ul style="list-style-type: none"> How is an object's motion affected by an interaction? How can we represent motion graphically? What is needed (if anything) to change the kinetic energy of an object? What is evidence that energy is changing? How can we represent energy changes and transfers?
Week 3 (10/7-11)	<ul style="list-style-type: none"> EM-A3: Slowing and Stopping Supplementary Activity: Simultaneous Interactions Review 	<ul style="list-style-type: none"> Why do moving objects tend to slow down and stop? Where does the energy go? What happens to the rate of change of speed of moving objects as the amount of friction changes? How can we describe friction interactions in terms of energy? How can we describe more than one interaction that combine to produce multiple changes in energy for multiple objects in a system? How can we describe interactions in terms of energy transfers and transformations?
Week 4 (10/14-18)	<ul style="list-style-type: none"> Take home quiz #1 due 2 PM Wed, 10/16 FM-A1: Interactions and Force FM-A2: Motion with a continuous force 	<ul style="list-style-type: none"> How is an object's motion related to the forces acting upon it? How does an object move when a force of constant strength continuously pushes it forward?
Week 5 (10/21-25)	<ul style="list-style-type: none"> FM-A3: Pushes and slowing down FM-A4: Forces and friction CF-A1: Combinations of forces 	<ul style="list-style-type: none"> What effect does a 'backward' push have on the motion of an object? What happens if a continuous 'backward' push is applied to a moving object? Is friction a force? If so, in what direction does it act? How does friction work? How do objects behave when more than one force acts on them?

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Dates	Units/Topics	Guiding questions
Week 6 (10/28-11/1)	<ul style="list-style-type: none"> ● CF-A2: Motion with Balanced Forces ● Review ● Driving questions: More interaction types ● Asset-based view of learning ● Take home quiz #2 due 2 PM Fri 11/1 	<ul style="list-style-type: none"> ● What is an object's motion like when a balanced combination of forces acts on it? ● How can we describe interactions in terms of forces? ● How can we build upon students' ideas about science? ● Why is this important?
Week 7 (11/4-8)	<ul style="list-style-type: none"> ● PEF-A1: Elastic objects & energy ● PEF-A3: Magnetic and Static Electric interactions & energy ● PEF-A4: Gravitational interactions & energy 	<ul style="list-style-type: none"> ● What energy changes take place in elastic objects when they are involved in contact interactions? ● How can we describe magnetic and static electric interactions in terms of energy? ● How does energy help explain things in different science disciplines? ● What energy changes take place when an object falls? ● How can we describe gravitational interactions in terms of energy?
Week 8 (11/13-15) No class 11/11	<ul style="list-style-type: none"> ● Energy as a Cross-Cutting Concept ● FM-A5: Changing force strength and mass 	<ul style="list-style-type: none"> ● What is common among different types of potential energy? ● Why is energy important to teach? ● When a single force acts on an object, how is the object's motion affected by 1) the strength of that force and 2) the object's mass?
Week 9 (11/18-22)	<ul style="list-style-type: none"> ● FM-A6: Falling objects ● Review ● Take home quiz #3 due 2 PM Fri 11/22 	<ul style="list-style-type: none"> ● How does the mass of an object affect how it falls? ● How do we describe gravitational interactions in our force model? ● How can we put our ideas about forces and energy together to explain different phenomena? ● What are the affordances and limitations of energy and force diagrams?
Week 10 (11/25) No class 11/27,29	<ul style="list-style-type: none"> ● EM-A4: Warming and Cooling 	<ul style="list-style-type: none"> ● What interactions change the temperature of objects? ● How do we describe these interactions?
Week 11 (12/2-6)	<ul style="list-style-type: none"> ● EM-A5: Electric circuit interactions ● Energy and Society ● Review and wrap up quarter 	<ul style="list-style-type: none"> ● How can we trace the flow of energy through a system of interacting objects (including the surroundings)? ● How is energy a social justice issue?
Thurs, 12/12	Final projects due 2 PM	

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UNIVERSITY RESOURCES AND POLICIES

I want each and every one of you to thrive at WWU, and in this class. I encourage you to check out and utilize the following list of resources. Check out this [Overview of Student Services](#) for even more.

- [WWU counseling center](#): Did you know about 1/3 of WWU students utilize the counseling center? Asking for help is ok! Please stop by, virtually or in person, if you are feeling anxious, depressed, overwhelmed, or just need to talk to someone.
- [Student Health Center](#): In case of a medical concern or question
- [Office of Student Life](#): In the case of a family or personal emergency
- [Resources for Racial Justice](#): self-care, learning, and Black-led LGBTQ+ organization

Reasonable Accommodation. Reasonable accommodation for persons with documented disabilities should be established within the first week of class and arranged through the [Disability Access Center](#): telephone 360-650-3083; email drs@wwu.edu; and on the web at [disability.wwu.edu](#). Review their [Documentation Guidelines](#) for the procedure for providing reasonable accommodations for students with disabilities. See also the [Accessibility Map](#).

Religious Accommodation. Western provides reasonable accommodation for students to take holidays for reasons of faith or conscience or for organized activities conducted under the auspices of a religious denomination, church, or religious organization. Students seeking such accommodation must provide written notice to their faculty within the first two weeks of the course, citing the specific dates for which they will be absent. “Reasonable accommodation” means that faculty will coordinate with the student on scheduling examinations or other activities necessary for completion of the course or program and includes rescheduling examinations or activities or offering different times for examinations or activities. Additional information about this accommodation can be found in [SB 5166: Providing religious accommodations for postsecondary students](#).

Academic Integrity:

- Academic Honesty: All Western Washington University students have an obligation to fulfill their responsibilities as members of an academic community. Academic integrity is demanded; moreover, academic dishonesty at Western is a serious infraction dealt with severely. No student shall claim as his or her own the achievements, work, or arguments of others, nor shall he or she be a party to such claims. It is the instructor’s responsibility to confront a student and to take appropriate action if such academic dishonesty has occurred. See [Appendix D: Academic Honesty Policy & Procedure](#) of the catalog for examples, procedures, and methods of appeal and [Ensuring Academic Honesty](#) for appeal rules and timeline.
- Plagiarism: Plagiarism is presenting as one’s own—in whole or in part—the argument, language, creations, conclusions, or scientific data of another without explicit acknowledgement. See the Library’s [Plagiarism Policies & Guidelines](#) for examples and citation guides. See [Appendix D: Academic Honesty Policy & Procedure](#) of the catalog for examples, procedures, and methods of appeal and [Ensuring Academic Honesty](#) for appeal rules and timeline.

COVID-19: Each student is responsible for understanding, and complying with, WWU’s [COVID-19 policies](#).

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